

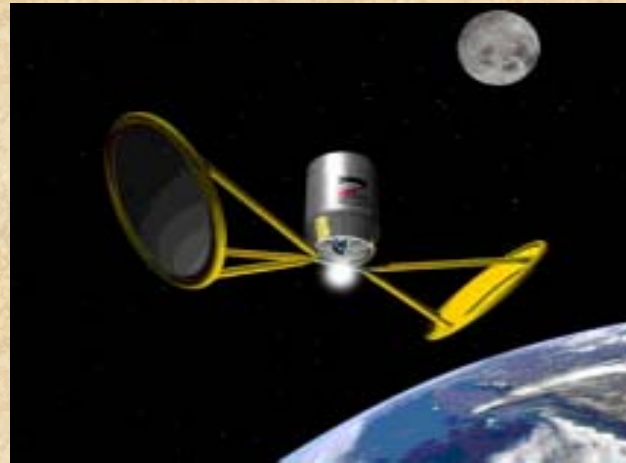
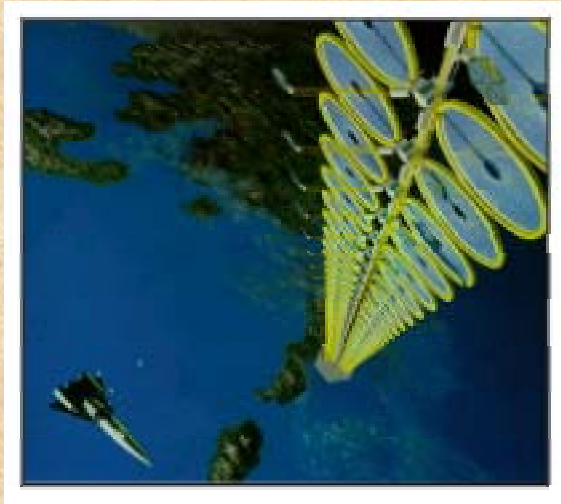
Thin Film and Inflatable Structures Technology for In-Space Fabrication

**Presentation to In-Space
Fabrication and Repair Research
Workshop, July 9, 2003**

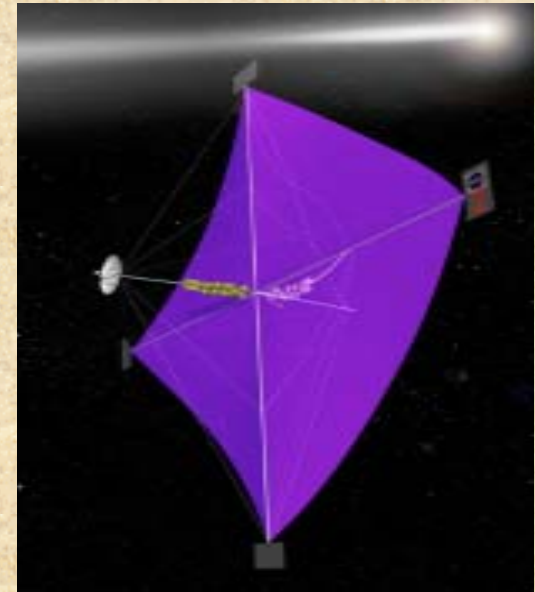
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Thin Film Structures



- **Antennas/Optics**
- **Space Power Systems**
- **Solar Sails**
- **Solar Thermal Propulsion**





MSFC activities in the past 5 years in thin film and inflatable structures technology:

1. *Dynamic test/modeling of thin film structures:*
 - (a) Inflatable 2-m concentrators for Shooting Star Experiment; also limited deployment experiments
 - (b) Inflatable 2x3-m, 5-m and 4x6-m lenticular elements--use of laser vibrometer system
 - (c) Cylindrical strut and circular membrane
2. *Deployment of thin film strut*
3. *Foam rigidization of cylindrical booms*

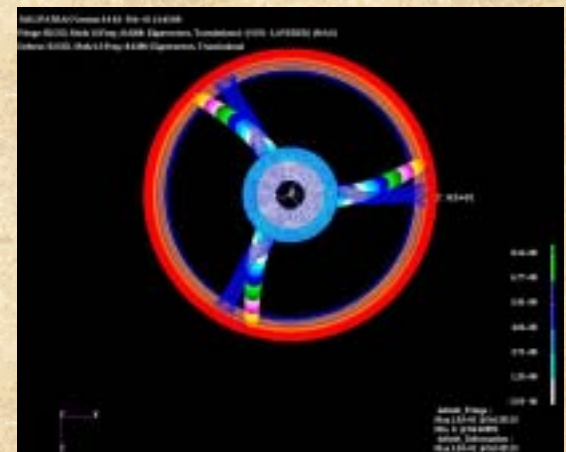
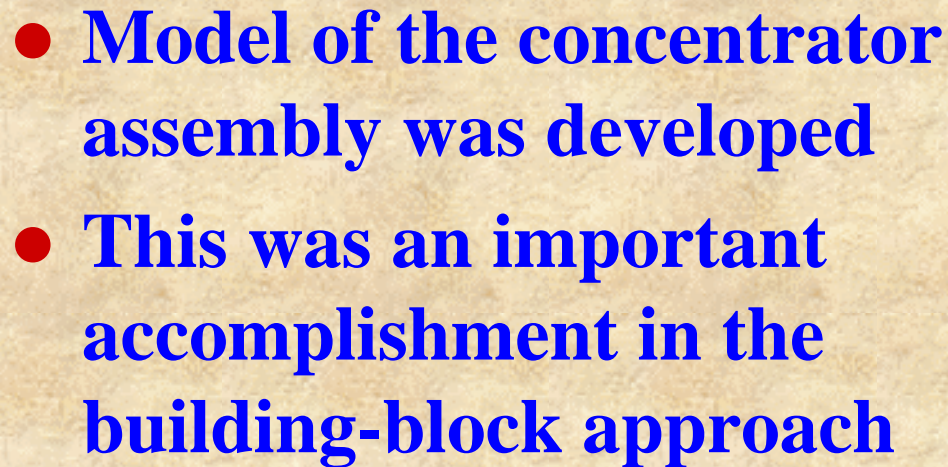


Description of Inflatable 2-Meter Concentrator



- Torus/strut assembly with lens simulator
- Tapered 6-ft struts of 2-mil polyimide film; diameter varying from 6.8" to 4"
- Struts attach to plate
- Torus with 6" cross-sectional dia. and 6-ft outer dia.







5-Meter Collector



Materials and Dimensions:

- Kapton polyimide torus and CP-1 lenticular, both 1-mil thick (7.5 lb)
- Solid composite struts (approx. 12.5 lb)
- Torus dimensions: 21-ft outer diameter and 2-ft cross-sectional diameter
- Lenticular size: 16-ft dia.





Dynamic Testing Approach



- Inflated torus and lenticular assembly mounted on a composite stand
- Shaker excitation applied on a strut
- Accelerometers on strut and stand
- Laser vibrometer used for responses on inflatable surfaces





4x6-Meter Inflatable Concentrator



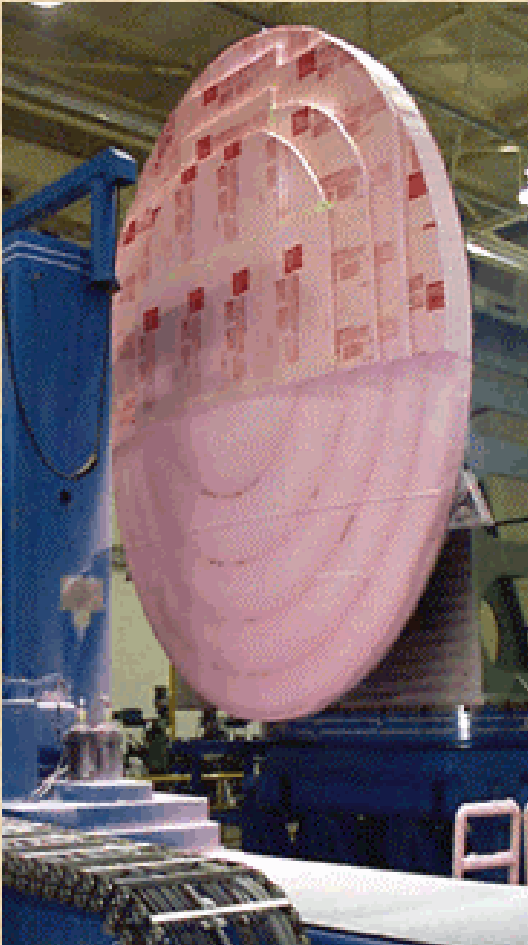
- Potential applications for propulsion, power, and communications
- Inflatable lenticular attached to aluminum fixture by catenaries
- Fixture to be supported horizontal to the floor by I-beam stands for testing





Mandrel Fabrication for Thin Film Concentrators

- MSFC manufacturing support for 4x6 meter inflatable concentrators

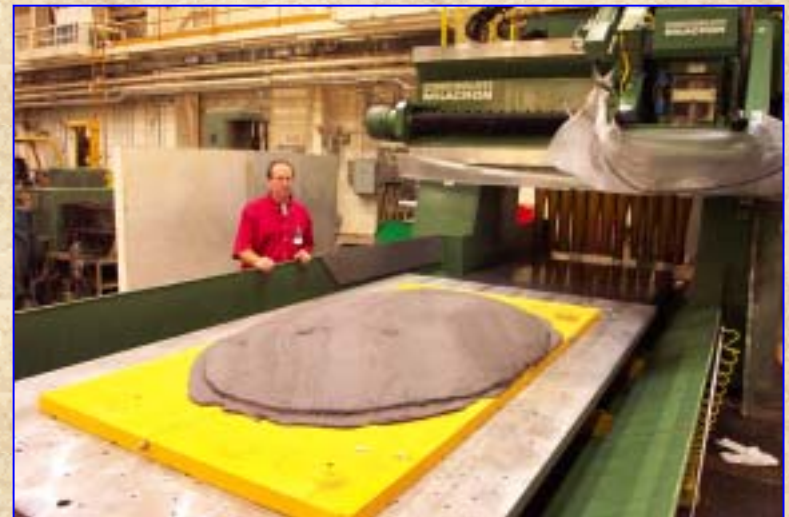
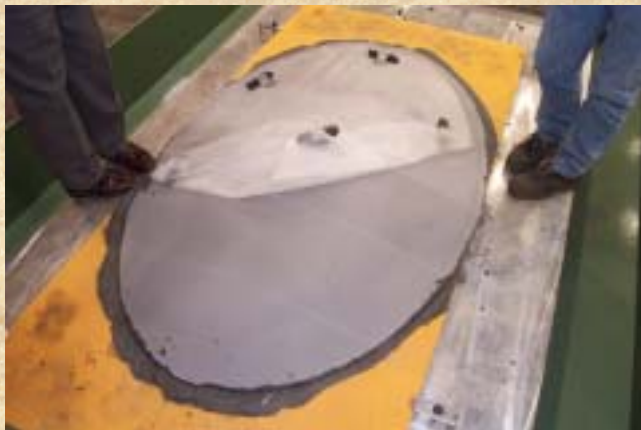




Manufacturing of Mandrel for Inflatable Concentrator



- **Machining of 1x2 meter mandrel at MSFC**





Deployment of Thin-Film Inflatable Strut



- Polyimide thin film strut and storage canister fabricated at MSFC by summer student
- Packaging and deployment experiments were conducted





Inflatable Structure Rigidization Technology



- Thin film inflatable concentrator
- Full-size structure tested in MSFC large vacuum chamber
- Quarter-scale model foam-rigidized by UAT





Foam-Rigidized Annular Strut Construction



- Annular tube constructed with polyimide film sleeves and polyurethane foam filler
- Boom segment with OD 3.5", ID 2.5" was successfully fabricated



Modal Testing of Foam-Rigidized Struts

- **Dynamic testing of struts manufactured by MSFC and United Applied Technologies**
- **Free suspension**
- **Lightweight hammer excitation**
- **Accelerometer response**





In-Space Fabrication Research Recommendations

- *In-space fabrication of booms*---
Investigate various materials, methods of deployment, and rigidization--including thin films with foam injection
- *Assembly of fabricated booms*---
Develop innovative joints and assembly techniques to construct (1) solar sails, (2) solar concentrators, and (3) solar arrays

